

be, if not "antagonistic to Darwin's theory of Natural Selection," at all events, as I expressed it, "an important emendation of Darwinism." My object, therefore, while reviewing the essay was to show that this is a character which does not belong to it. If I have misunderstood the meaning of its author on this fundamental point, I should have been glad to have received a more express statement of the fact than appears in the above letter; for I might then have felt that Mr. Dixon's views with reference to the value of his work are in full accordance with my own. As stated in the review, I consider his facts most interesting as examples of trivial specific characters—or slight variations of a fixed kind—due to variation presumably unaided by selection; and when I said that such facts "may be freely presented to the anti-Darwinians," I meant that they might be so presented to any one who supposed them anti-Darwinian. It appeared to me that Mr. Dixon himself regarded them in this light (though not as anti-evolutionary), at all events to the extent of imagining that they had not been sufficiently recognised by Darwinians. But, as I have said, if such is not his meaning, I am very glad to find myself in agreement with him upon this point.

I spoke of these trivial specific characters as "odds and ends," and as of "comparatively rare occurrence," because, although both numerous in themselves and of importance for the purposes of detailed classification, they are insignificant when compared with the whole organising work of natural selection. And if, as Mr. Dixon now repeats, it was the object of his little book "to try and explain the agents" (*i.e.* the *causes*) producing these non-purposive specific characters, I can only repeat that in this respect his book has failed in its object. Lastly, my only reason for not mentioning Mr. Dixon's views on natural selection, &c., was that I found nothing in these views particularly deserving of mention.

GEORGE J. ROMANES

#### On Radiation of Heat from the Same Surface at Different Temperatures

WITH respect to my recent communication to you on the subject of radiation of heat at different temperatures (p. 85), I wish to remark that the temperature given as the temperature of the surroundings must be taken as only approximate. A remark to this effect was in fact included in the first draft of my note to you, and was inadvertently omitted in the final copy.

If the glass envelope surrounding the wire were perfectly diathermanous, and likewise the intervening air, then the temperature of the surroundings would be simply that of the walls of the room. As it was there is a great difficulty in saying precisely what is to be taken as the temperature of the surroundings. The glass envelope becomes heated to some extent, and will return a certain amount of radiation to the wire. When the vacuum is nearly complete, however, the heating of the glass is slight, and is very small in comparison with the heating when the vacuum is only partial.

The reason I have not used a metallic envelope blackened inside and cooled outside, is that it is very difficult to attach such an envelope in a satisfactory way to the Sprengel pump. I am, however, hopeful of being able to overcome this difficulty.

November 28

J. T. BOTTOMLEY

#### THE NOVEMBER METEORS

THE watch which was kept on November 27 in the hopes of seeing a shower of meteors from the stream connected with Biela's comet was very amply rewarded. At the Royal Observatory, Greenwich, the weather was somewhat unfavourable, the sky being partly clear only at intervals, yet, when the meteors were first seen, between 6h. and 7h. p.m., they were appearing at the rate of from 30 to 40 per minute. The average brilliancy of the meteors was remarkable. The radiant-point as determined at the Greenwich Observatory from a number of paths was estimated to be about R.A. 20°, Decl. 49° N.

We have received the following communications with reference to the meteor showers:—

THE great display of Andromedes, or meteors of Biela's comet, which occurred on the evening of November 27 last, and which fortunately has been widely observed,

adds another corroborative link to the theory, already demonstrated by facts, connecting comets and meteors. Not only does this stream exhibit a perfect orbital resemblance to that of the comet with which it has been associated, but it recurs only at the special times when, according to computation, the comet is in the vicinity of that region of its orbit encountered by the earth on November 27.

Many meteors appeared on the evening of November 26 this year, the hourly rate, as estimated at Bristol, being considerably over 100, and they nearly all belonged to the shower from Biela's comet. But the display on that night was not of very exceptional richness, though it gave distinct intimation of what was to follow. The meteors of November 26 were simply the *avant couriers* of the advancing host, for, as soon as twilight deepened on the following evening, it was seen at once that the shower had greatly intensified. Meteors were falling so thickly as the night advanced that it became almost impossible to enumerate them. Frequently they came in simultaneous groups of five, seven, or ten, all radiating from the immediate region of the star  $\gamma$  Andromedæ, and appeared in every quarter of the firmament with that uniform slowness of movement which is a peculiar feature of the shower.

The prediction that such a display would occur has thus been completely verified, and the character of its leading features has been precisely conformable to anticipation. For not only has a meteor-shower occurred at the appointed time, but it has coincided in all its salient attributes with what has been expected. The radiant-point near  $\gamma$  Andromedæ has been accurately marked, as on November 27, 1872, and the meteors have presented the same visible traits of appearance.

As to the strength of the display, it has been variously described, but there can be no doubt, from the observations, that it will rank in importance with any similar phenomenon recorded in modern times. At stations where the clearness of the atmosphere permitted its full grandeur to be recognised, it would seem that about one meteor per second was counted, and this means a rate of 3600 per hour.

These facts warrant us in the assumption that the earth has recently encountered a very dense region of the meteor-stream. Notwithstanding that these meteors have to overtake the earth in her orbit, and that they therefore travel with the minimum velocity (about eleven miles per second) possible in the case of such bodies, they have returned in surprising abundance. A far more attenuated system, encountering the earth under similar conditions to the Leonids of November 13, which directly meet the earth in her path, must have originated a more numerous display, because a far greater range of such a stream would be traversed in the same interval. Here the velocities of the earth and meteors would be combined by the favourable circumstances of the *rencontre*, and the earth would really penetrate the stream at the rate of some forty-four miles per second. But in the instance of the meteors from Biela's comet, they are travelling in the same general direction as ourselves, and it is only their greater native velocities which enable them to catch up the earth, and become visible in the form under which we have just observed them.

When all the accounts of this remarkable display become available for reduction, it will be important to compare them with those of its predecessor in November, 1872. Though the present shower has been an obvious repetition of the one just referred to, it may exhibit some differences which it will be essential to investigate. In one respect certainly there would appear to be a want of accordance. We refer to the relative durations of the two displays. In 1872, on November 26 and 28, that is, on the nights preceding and following the great shower, very little sign of it appears to have been observed. It was

immediately confined to the night of November 27. In NATURE, vol. vii. p. 104, Prof. Herschel writes:—

"On the evening of the 28th [November, 1872], Mr. Greg watched for shooting-stars, and for any remnants of the star-shower of the previous evening which might be visible, but although the sky was quite clear, he failed to see any meteors. A strict watch for outlying meteors of the shower was also kept by two observers at Hawkhurst, in Kent, on the evening of the 28th, where the sky was quite cloudless between 9h. and 11h. 15m. p.m., but without success, only four shooting-stars of ordinary character being visible."

Prof. Herschel also quotes some observations proving that on November 26 of that year, meteors were singularly rare, and justly concludes from this that the display was confined to an interval of forty-four hours. Now the recent phenomenon was already a conspicuous shower on the 26th, when it was observed at Bristol at about 8.30 p.m., and on the 28th, in a four-hours watch before 11.30, 55 Andromedes were counted in a cloudless sky. We here have a period of fifty-one hours for its observed duration, but there is not the slightest doubt from the activity it exhibited at the opening and termination of the observations this year, that the shower must have been probably visible both on November 24 and 25, and also on the 29th. At Bristol the sky was overcast on these dates, so that the progress of the display during its complete rise and decadence could not be observed. It is certain, however, that it extended over several nights, and that its increase was more gradual, as in the case of the August Perseids, than its decline.

The outlying members of the shower observed at Bristol in the very clear sky of November 28 this year were extremely faint, the majority being of the 5th and 6th magnitude. It is therefore suggested that on the environs of the denser part of the stream, the meteors are of very diminutive size, and this may possibly have enabled them to elude detection at places where the atmosphere was not very clear. W. F. DENNING

AN extraordinarily bright display of Cassiopeiad shooting-stars occurred this evening, commencing, I am told, as soon as darkness set in, at about five o'clock. The sky was then cloudless here, but owing to street-lights I missed observing them between five and seven, and until informed of their appearance a little after half-past seven o'clock. Reaching an open space, and looking up at Cassiopeia, just overhead, I then counted about twenty meteors, all with short courses near that constellation, in the four minutes onwards from 7.40. Such a thick haze overspread the sky except just round the zenith, that only the bright stars of Cassiopeia and two in the Square of Pegasus ( $\beta$  Pegasi and  $\alpha$  Andromedæ) were visible there; but several first and second magnitude meteors of the display which proceeded at the same rate until 7.50, left streaks on their short courses visible for two or three seconds through the haze, and these being sometimes actually in sight in groups together, made the direction of radiation very easy to determine. The thickening haze, however, hid the stars so completely at the latter hour, and afterwards, that further observations of the shower for the night have proved fruitless.

To my surprise, this active meteor-shower was diverging, not from the usual Biela radiant-point near  $\gamma$  Andromedæ, but the short meteor-tracks all streamed away from Cassiopeia! This was conspicuous in the meteors near Cassiopeia which travelled thence, as most of those visible did, westwards and southwards towards the Square of Pegasus across Honores Frederici, and eastwards and northwards across Camelopardus and Custos Messium. Although no faint stars in sight allowed their courses there to be regularly mapped, yet, from such a short collection of very good accordances for fixing it very nearly, I would place the radiant-point (by rough eye-estimation

only) very near  $\alpha$ , or between  $\zeta$ ,  $\eta$ , and  $\theta$  Cassiopeia, which is about  $15^\circ$  from the Biela radiant-point near  $\tau$  Andromedæ.

In his "Periodische Sternschnuppen," published at Aix-la-Chapelle in 1849, Heis described a radiant-point of several meteors seen there by him on the nights of December 8 and 10, 1847, between  $\gamma$  and  $\tau$  Andromedæ, as a prominent one on those nights; and on the evening of November 30, 1867, Zezioli, at Bergamo, mapped a number of meteor-tracks, from which Prof. Schiaparelli obtained a well-marked radiant-point position closely agreeing, like Heis's, with the subsequent exact determination of the place of the "Andromede" star-shower's radiant-point made by numerous observers of the shower's great return on November 27, 1872.

Besides the radiant "A" in Andromeda, seen on the nights of December 8 and 10, 1847, Heis also described, in the same work, another, "C," close to  $\alpha$  Cassiopeia, as conspicuous on the nights of November 12 and 13, in the years from 1839 to 1847; and he notices that Danse (*Comptes rendus*, vol. v. p. 759), on November 15, 1837, observed a shower of seventeen shooting-stars in a minute and a half diverging from the constellation Cassiopeia. In connection with the December epoch it is also noted that of a large number of meteor-tracks observed by Herrick at Newhaven, U.S., on December 7 and 8, 1838, about three-quarters diverged from the principal stars of Cassiopeia, and that Flaugergues, at Toulon, in France, made a similar observation on December 6 of the same year, 42 meteors, about 9 o'clock, falling vertically from the zenith, and 31 of them on nearly parallel courses from about Cassiopeia's place in it (as the account implies) between the Milky Way and the Square of Pegasus.

Although the connection of this "Cassiopeiad" stream with Biela's comet would seem, from the position of its radiant-point, to be somewhat doubtful, yet the occurrence now, as it appears, of a shower with nearly the same radiant point on the night of the famous Biela star-shower's date in 1872, makes the probability much greater than before that the "Cassiopeiads" of December 6 to 10 and the "Andromedes" of Heis, belonging to the same date and to November 27 to 30, may not be unassociated star-showers, but that both may possibly have had their origin in some bygone disruptions of Biela's comet! The position of this star-shower's radiant-point will, it is to be hoped, have been determined accurately by more fortunate observers than myself of its very striking apparition, so as, if it befits them, to corroborate these slight observations generally, and to fix the shower's centre of divergence with the astronomical position which is most desirable from these suggestive indications.

Four Leonids, varying from first to third magnitude stars in brightness, and leaving no streaks, were seen here between 2.10 and 2.50 a.m. on the 15th inst., together with two small sporadic meteors, in a clear moonless sky. They indicated plainly, by the accordant radiation outwards on a map of their long swift courses, from a moderately wide area in Leo's Sickle, a slender recurrence of that great star-shower this year. Its maximum now appears to present itself at least as distinctly on the morning of the 15th, as on that of the 14th of November, as the nodal line of the meteor-stream advances. Its short-lived displays, it may be gathered from this regular progression, need scarcely now be looked for any longer, on that account, on either of the historically famous dates of the 12th and 13th of November, of its once pre-eminently grand and imposing exhibitions, while a centenary view of one of those is not actually now a very distant event to look forward to on a coming 15th of November morning in the year 1899.

A. S. HERSCHEL

Newcastle-on-Tyne, November 27



P.S.—November 28.—On looking at the stars in a clear sky to-night, I find that those described above as having been just visible near Cassiopeia were not chief stars of the Square of Pegasus, as supposed, but bright stars in Cygnus and Cepheus! Instead of crossing Honores, therefore, the chief meteor-flights of the stream observed were shooting from the true Biela radiant-point near  $\alpha$  Andromedæ, past Cassiopeia into Cepheus. Other stragglers there certainly were, whose general radiation from Cassiopeia could not be thus accounted for. Just similar variations of direction, however, were common among a rather large proportion of the “Andromedes” in the great shower of November 27, 1872, which had rather an average than a very sharply marked radiant-point in Andromeda. There appears no reason to doubt, therefore, that on this occasion also the shower proceeded from the same prevailing centre of divergence.

From many observers' descriptions of it here, the present shower would seem to have been hardly, if at all, inferior in any respect—of duration, of brightness and multitude of its meteors, or of persistency in the light-streaks left upon their tracks—to the great and well-remembered display of the Biela's comet meteor-shower in November, 1872.

As you may be desirous to make known any observations respecting the meteor-shower of the 27th inst., I beg to furnish you with those noticed by myself.

At sunset the sky was overcast, but happily at 6.30 p.m. the clouds dispersed, when the phenomenon was seen here in full splendour; the heavens were alive with the meteors making their rapid appearance and extinction.

My attention was attracted chiefly to the constellations of Cassiopeia, Andromeda, and towards Perseus, from whence the most brilliant portion of the shower was in operation, and from that locality the most conspicuous meteors shot forth. Selecting the most remarkable out of the numerous luminous trains for their length of traverse, and conceiving the line of direction to be thrown backwards, the convergence of these trains concentrated towards a point in Andromeda, in accordance with the position of the radiant-point as predicted in the Dun Echt Observatory Circular.

The paths taken by the above meteors were, in many cases, directed towards the southern horizon, and several towards the Pleiades in the east, from the radiant-point; others flitted away to every point of the compass, exhibiting longer or shorter trains during their ephemeral existence.

The general illuminating effect produced by the shower was appreciable, but it was not very powerful; and with regard to the colours which were exhibited in the luminous trains, my views combined with the opinions derived from other observers coincide—that the colour aspect of these transient illuminants varied apparently between golden and very pale-green tints.

But with reference to the zenith and its surrounding region, it was noticeable there that the conditions of the meteors had other characteristics, inasmuch as they were almost devoid of path or connection with any radiant-point, they were remarkably numerous, a great proportion of them exhibited no more than feeble flashes or scintillations of white light, the display was maintained with great rapidity and continuously.

It was also noticed that an erratic meteor was seen occasionally taking an independent course of considerable length, about  $45^\circ$  of arc, sometimes at low elevation, making an acute angle with the horizon.

About 7.15 p.m. clouds obscured the sky for the night, so I did not see either the beginning or the termination of this interesting phenomenon.

Comparing the great display of meteors which I observed in November, 1866, it was in all respects more

magnificent than this recent shower. I could not on this occasion define any head or nucleus to any of the luminous trains, but this feature was remarkable in the large meteors of 1866.

As a single observer, it was impracticable for me to attempt any enumeration of the enormous number of meteors, and to observe the prominent features of the phenomenon at the same time. At midnight it was blowing a strong gale from the south-west; thick weather, with a mild temperature of  $53^\circ$ .

ERASMUS OMMANNEY

Yarmouth, Isle of Wight, November 29

THINKING, from the character of the weather on the night of the 27th, that opportunities of seeing the late splendid display of meteors may have been extremely local, I have taken the liberty of forwarding my notes of them as I saw them here from between a little before 6 p.m. until 7.35 p.m. How long the shower had been going on before (attracted by the cries of some passing boys) I looked out, I cannot say, but just before six when I did so, the sky was covered in many places with a thin haze, through which the larger stars and planets were looking greasy, as sailors say, while in nearly every direction meteors were gliding and bursting from a point a little to the eastward of the zenith toward the horizon; the meteors varying in brightness from that of the planet Venus to the faintest streaks of light. The larger ones were very like pale inverted rockets, having trains of many degrees in length, and often prismatic in colour; that is, near the head the light of the train was bluish, blending from green to yellow, followed by rose or crimson sparks. In many cases this train was visible for quite thirty seconds after the star was burnt out, first as a bar of warmish dusky light, and often becoming curved, as though by wind, as it faded away.

The silence of the display was almost oppressive, as one expected each moment to hear the bang of fireworks. During most of the time masses of luminous-looking vapour floated slowly across the sky. Some of the meteors seemed to burst end on, right over head, and though, being foreshortened, these left no train, yet they were among the brightest. I noted a considerable variation in the speed of the meteors, and am inclined to think that those which appeared farthest off moved slowest. It was next to impossible to say in which direction the star rain was thickest, for just as one was trying to make up one's mind upon this point, a troop of stars from an unexpected part of the sky would appear. Other observers may be able to speak more positively than I can upon this subject; but my impression, as well as that of those who saw them with me, was that they streamed down in groups of two, three, and four toward almost every point of the compass. About 7.20 p.m. the number seemed to become rather less, and at 7.35 this was markedly the case, though they were quite frequent enough then to have attracted attention any other night. Shortly after 7.35 the sky here became overcast by a storm-cloud, and it has remained so ever since, blowing a hard gale at S.S.W.

ROBERT LESLIE

Moirs Place, Southampton, November 28

A BRILLIANT display of the Andromedes was seen here on the night of November 27 from about 6 p.m. to 9 p.m., after which time the sky was clouded over. During a walk of ten minutes (from 6.20 to 6.30), facing the north-west, I counted 150 meteors within that half of the visible heavens; and as they appeared to be nearly if not quite as numerous in the other half their total number would not be less than 1500 per hour. The radiant point was almost directly overhead. The meteors varied greatly in size, many being very small and faint. The larger ones left bright trails of a white or bluish colour. I observed one only in an opposite direction, and none with curved or zigzag paths. The shower was less grand than that of

the Leonids in 1866, in which there was a larger proportion of brilliant meteors, many of them coming in flights of three to six at once, all near together; but with that exception the display of the Andromedes this year was the finest piece of celestial pyrotechny I have ever had the good fortune to witness. We seemed to stand under an encircling canopy of dropping lights.

Birstal Hill, Leicester, Nov. 28 F. T. MOTT

AN extraordinary meteoric display was visible here last night. I first observed it at 6.40 p.m., and was watching it at intervals for more than an hour later, when the sky became overclouded. Altogether the number of shooting-stars was immense. Unlike the correspondent of the *Daily News*, who observed a similar phenomenon at Naples the same night, I was unable to count the number per minute. Appearing suddenly, and often many at a time, in all parts of the heavens, from the zenith to the horizon, they quickly disappeared from view, the distance travelled not being more than a few degrees in any case. Some were much more luminous than others, and all in their passage through the air were followed by the usual trail of light.

E. F. BATES

Leicester, November 28

THOUGH densely cloudy during the afternoon of the 27th, the sky became clear here about 6.30 p.m., when great numbers of meteors were to be seen, falling at the rate of fully 60 per minute, many being of great brilliancy. During the evening their number gradually decreased, till towards 10 o'clock very few were visible. The sky then again became overcast.

PERCY T. INGRAM

Belvoir Gardens, Grantham, November 29

THE star-shower predicted by several astronomers was well seen here on Friday evening last. When first observed, at 5.30, the rate of fall was 25 per minute; the numbers, however, increased rapidly during the next half-hour, till, at 6 o'clock, more than 100 meteors were counted in a minute.

At 6.20 a marked decrease in the intensity of the shower was noted; but at 6.38 the numbers once more increased, till a rate of 70 per minute was attained; after this, however, they gradually diminished as the hours went on. It is right to mention that the numbers given above are those of the meteors seen by an observer looking towards the east; they do not represent the total number that fell at these two periods.

The radiant-point, as indicated by the position of several meteors which suddenly flashed out without sensibly changing their position, was close to  $\gamma$  Andromeda, or, more exactly, R.A.  $21^\circ$ , N.P.D.  $46^\circ$ .

Most of the meteors were mere "shooting-stars"; a large number, however, had brilliant phosphorescent trains, which continued to glow for several seconds after the meteors themselves had vanished. Occasionally one of the trains would break up into fragments, and in one instance a curious spiral form was assumed.

A special feature of the shower was its varying intensity, and that more particularly between 6 and 7 o'clock.

JAMES SMITON

Broughty Ferry, Dundee, November 30

OUR Paris Correspondent writes:—The shower of falling stars has been observed at a number of French stations—Toulouse, Central France, Tunis, and Algiers. The point of emanation was, in the case of some of them, between Andromeda and Cassiopeia. In Paris it was not observed, owing to the foggy state of the atmosphere, and no balloon observation having been tried.

The following letters on the meteors appeared in the *Times* of Saturday:—

Mr. T. G. Dyson, of 1, Rothesay Villas, Windsor, wrote on Friday night:—"I was fortunate in witnessing this evening from 6.15 to 6.40 a most magnificent shower of stars, which might be compared to a flight of swallows, with a lull of a few seconds between each flight. Although the sky was anything but clear—only stars of the larger magnitude being visible—the meteors were brilliant, and in many instances left a distinct trail behind them. The direction was principally from east to west, varying to north-west."

The Leicester Correspondent of the *Times* telegraphed last night:—"A remarkable display of meteors was witnessed in Leicestershire to-night from dusk until a late hour. The display was most brilliant towards the western horizon, the meteors falling in perpetual showers, with brilliant trails, like a very fine display of fireworks."

A Reuter telegram from Athens, dated November 27, says:—"A brilliant shower of meteors was observed here to-night."

A Newcastle-on-Tyne correspondent telegraphs:—"There was a splendid meteoric display here. I saw about 500 an hour. Radiating point Cassiopeia."

Prof. Pritchard, of the University Observatory at Oxford, telegraphs that he counted 251 meteors between 6.34 and 6.39 p.m., and 305 between 7.14 and 7.19.

IN case no one else may have reported the complete fulfilment of the prediction suggested by Lord Crawford's Dun Echt Circular allow me a few lines to do so.

I did not begin to observe systematically until nearly 8 p.m. (7h. 58m.), when I found that, confining my attention to one-third of the sky (south-south-east to west-north-west), and computing therefrom, meteors were falling at the rate of 33 a minute. Shortly after this they became more numerous, and from 8h. 5m. to 8h. 10m. they were falling at the rate of 56 a minute (nearly one a second), or more than 3000 an hour. From 8h. 30m. to 9h. 30m. the view was much hindered by cloud, but it was evident that the number was decreasing. From 9h. 30m. to 10h. the average fell to about 12 a minute, or scarcely a fifth of what it was at 8h. 5m.; and shortly after 10 p.m. the sky became entirely overcast.

I well remember the glorious shower in 1866. On that occasion the meteors were both larger and more numerous than they have been this evening, but occasionally they were very frequent—for example, at 7h. 59m. five were visible in less than two seconds (the precise period was one second and six-tenths).

G. J. SYMONS

62, Camden Square, N.W., November 27

In Paris, according to the *Times* Correspondent, the sky was overclouded all Friday night, but the meteor-shower was seen to advantage in the South of France, in Belgium, Germany, Spain, and Italy, as also in Tunis, where the natives were much startled. At Châtelherault the meteors were well seen. At Cologne, Dr. Klein counted 636 between 6 and 7 o'clock, though the sky was at times overclouded. Most of them moved very slowly and left a trail of light, which quickly disappeared. Four were large and brilliant enough to be styled fire-balls. From 7.30 to 8 he counted 309, from 8.30 to 9 there were 375, and from 9 to 9.30 there were 208. The sky then became cloudy. Not one can have reached the ground, for they must have burned out and dispersed in the upper atmosphere. At Munich the sky was perfectly clear, and the display was very striking.

#### THE LATE SIR WILLIAM SIEMENS

ON Thursday last the relations and friends of the late Sir William Siemens assembled in the Jerusalem Chamber of Westminster Abbey for the purpose of doing